PETROGRAPHIC AND CHEMICAL CHARACTERIZATION OF POTTERY OF PHOENICIAN TRADITION FROM EARLY TARTESSIAN CENTERS

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Abstract: This paper presents the preliminary results of a study of wheel-thrown ceramics from three archaeological sites located in western Andalusia: El Carambolo, Huelva (La Joya) and Setefilla, combining X-ray fluorescence spectrometry and thin-section petrography. The analysis undertaken provides useful data to define clay matrix, temper and elemental composition of local Phoenician style ceramics. The first results indicate a link between archaeological sites and the elemental composition of the analyzed sherds. This study shows that the ceramic wheel-thrown pottery gathered from the investigated sites is not homogeneous and presents a variability of petrographic and chemical properties.

Keywords: XRF; Petrography; Pottery; Tartessos; Iron Age.

1. Introduction

The aim of the paper is to present the petrographic and chemical results of pottery in the Phoenician tradition from sites of strong oriental influence. The term "pottery in the Phoenician tradition" refers to the wheel-thrown pottery clearly inspired by oriental ceramic products. This kind of pottery could be imported from the Phoenician colonies of the coast or manufactured in Tartessian sites in western Andalusia. "Orientalizing" is a useful term to define the hybrid material culture of Phoenician technologies and styles of the indigenous population[1] without having to distinguish between "Phoenician" and "Tartessian".[2] In this study samples from three Early Iron Age archaeological sites are examined: El Carambolo, Setefilla, and Huelva (La Joya). These sites are representative of the Orientalizing period in south west Iberia (Fig. 1).

The ceramic materials analyzed are dated to the Early Iron Age. The foundation of the earliest Phoenician settlements is normally perceived as a chronological caesura between the Late Bronze Age and Early Iron Age in southern Iberia. In recent years the chronology of Phoenician contexts in Iberia has been changed significantly. The oldest Phoenician sites located on the Mediterranean coast, like Toscanos or Morro de Mezquitilla, date to the end of the 9th century BCE.[3] It should be added that the oldest radiocarbon dates (10th century BCE) are related to the finds in Huelva (Méndez Núñez 7-13 – Plaza de las Monjas),[4] however, absolute dates are not available for the necropolis at La Joya. Unfortunately, the same concerns materials from El Carambolo. On the other hand, new radiocarbon analysis of cremated bone samples from barrows A and B at Setefilla indicate that wheel-thrown pottery was present in the transitional period (840/820-770/750 cal

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1 Pappa 2013, p. 53.

2 Celestino – López-Ruiz 2016, p. 14.

3 Brandherm 2008, p. 97; Torres Ortiz 2008, p. 74.

4 Torres Ortiz 2008, p. 65.

Fig. 1. Localization of the most important archaeological sites of western Andalusia (by V. Moreno Megías).

BCE) and of course in the Orientalizing period (post-770/750 cal BCE).[5] Unfortunately, the oldest wheel-thrown pottery was not available for this study, therefore the samples date from the 8th until the late 7th BCE.

Setefilla, Huelva (La Joya) and El Carambolo are remarkable examples of Tartessian centers with strong Phoenician influences. El Carambolo is one of the emblematic Early Iron Age archaeological sites of western Andalusia. It is known for the discovery of a treasure hoard in 1958[6] and a big sanctuary.[7] Setefilla became a reference site for all researchers interested in Tartessian culture due to the publication of literature about the necropolis[8] and the neighboring settlement. La Joya, located in the town of Huelva, is a site where materials of exceptional quality were found.[9] Huelva, due to its relative proximity to Cádiz, became an important intermediary between the Andalusian mining areas and the Phoenicians. The necropolis of La Joya together with the necropolis of Setefilla are sites of particular interest[10] since they constitute well-excavated and published Early Iron Age cemeteries. The petrographic and chemical results can therefore be placed in a broader archaeological context.

The underlying rule of the sampling strategy was based on the need to extract samples that represented the key characteristics of wheel-thrown pottery from the three sites investigated (Fig. 2.1-2.10). Extraction of samples from pots of known form was attempted but it was not always possible due to the poorly preserved ceramic material. The list of samples analyzed in this paper is presented in Tab. 1.

2. Methods

Twenty-two samples from three different archaeological sites were petrographically described. The pottery samples were transformed into 30µm thick thin sections at the laboratory of the Institute of Geology of the Adam Mickiewicz University in Poznań. These slides were analyzed under a standard Motic polarizing light microscope (BA-310 POL), using magnifications from 4x to 60x. The definition of the composition and microstructure of the samples studied followed the usual method for archaeological petrographic description[11] and quantification.[12] The samples were grouped according to common associations of technological features, minerals and rocks. Previous archaeometric research has taken into account the phase between the Late

5 Brandherm – Krueger 2017, pp. 305-306, 313.
6 Carriazo Arroquia 1973.
7 Fernández Flores – Rodríguez Azogue 2005.
8 Aubet 1975; Aubet 1978; Aubet 1980-1981.
9 Garrido Roiz 1970; Garrido Roiz – Orta García 1978.
10 Torres Ortiz 1999.
11 Whitbread 1989; Whitbread 1995; Quinn 2013.
12 Rice 1987, p. 348.

Sample	Archaeological site	Archaeological context	Form	Inventory number	Petrographic group	Chronological contex / ^{14}C determination)	References
8	Setefilla	Grave B7	cup	St.B. 104	D	Orientalizing period	Aubet 1978, pp. 23-24
18	Setefilla	Grave A2	plate	St.A. 84	D	Orientalizing period	Aubet 1975, pp. 24-25
70	Setefilla	Grave A26	plate?	St.A. 539	D	Orientalizing period	Aubet 1975, p. 47
84	Setefilla	Grave A62	plate	St.A. 1090	D	Orientalizing period	Aubet 1975, pp. 73-75
86	Setefilla	Grave A9	?	St.A. 169	D	Orientalizing period	Aubet 1975, pp. 28-29
127	Carambolo	? (excav. of 1958)	plate	REP 15033	A	Orientalizing period	Carriazo 1973
128	Carambolo	? (excav. of 1958)	bowl	REP 15033	A	Orientalizing period	Carriazo 1973
130	Carambolo	? (excav. of 1958)	bowl	REP 15082	B	Orientalizing period	Carriazo 1973
139	La Joya	Grave 8	plate	4241	C	Orientalizing period	Garrido 1970
140	La Joya	Grave 12	bowl	4247 (inv. 4)	C	1st half of the 7th century BC	Garrido Roiz – Orta García 1978, pp. 24-38; Torres Ortiz 1999, p. 63
141	La Joya	Grave 16	plate	4231 (inv. 9)	C	1st half of the 7th century BC	Garrido Roiz – Orta García 1978, pp. 48-63; Torres Ortiz 1999, p. 63
143	La Joya	Grave 16	Cruz del Negro urn	4231 (inv. 3)	C	1st half of the 7th century BC	Garrido Roiz – Orta García 1978, pp. 48-63; Torres Ortiz 1999, p. 63
146	La Joya	Grave 19	*à chardon*	4251 (inv. 4)	B	Orientalizing period	Garrido Roiz – Orta García 1978, pp. 154-165
147	La Joya	Grave 19	amphora	4251 (inv. 9)	B	Orientalizing period	Garrido Roiz – Orta García 1978, pp. 154-165
148	La Joya	Grave 19	amphora	2708 (inv. 10)	B	Orientalizing period	Garrido Roiz – Orta García 1978, pp. 154-165
149	La Joya	Grave 19	*à chardon*	2708 (inv. 8)	B	Orientalizing period	Garrido Roiz – Orta García 1978, pp. 154-165
157	La Joya	Grave 12	bowl	4247 (inv. 1)	C	1st half of the 7th century BC	Garrido Roiz – Orta García 1978, pp. 24-38; Torres Ortiz 1999, p. 63
173	Setefilla	Grave A41	?	REP 1982/1369	D	Orientalizing period	Aubet 1975, pp. 58-60
185	Setefilla	Tumulus A	?	St. A. 1075	D	Orientalizing period	
186	Setefilla	Tumulus A	?	St. A. 527	D	Orientalizing period	
188	Setefilla	Grave A21	*à chardon*	St. A. 370	D	Orientalizing period	Aubet 1975, p. 42
191	Setefilla	Grave A10	?	St. A. 174	B	2557± 45	Aubet 1975, p. 29; Brandherm – Krueger 2017, p. 305

Tab. 1. List of samples included in this study (by the authors).

Bronze Age and the Orientalizing period in the south western Iberian Peninsula[13] and provides interesting results for comparison with the analyzed pottery.

The analysis of the chemical composition of the samples was conducted using the Bruker Tracer III SD handheld X-ray fluorescence spectrometer. There are several advantages of using this method: relatively low cost of analysis, non-destructiveness, and rapidity. Nevertheless, the disadvantages are significant and include lower precision than laboratory equipment, the ability to analyze only the surface of the examined artefacts and the semi-quantitative nature of the data.

13 Cordero Ruiz *et al.* 2006.

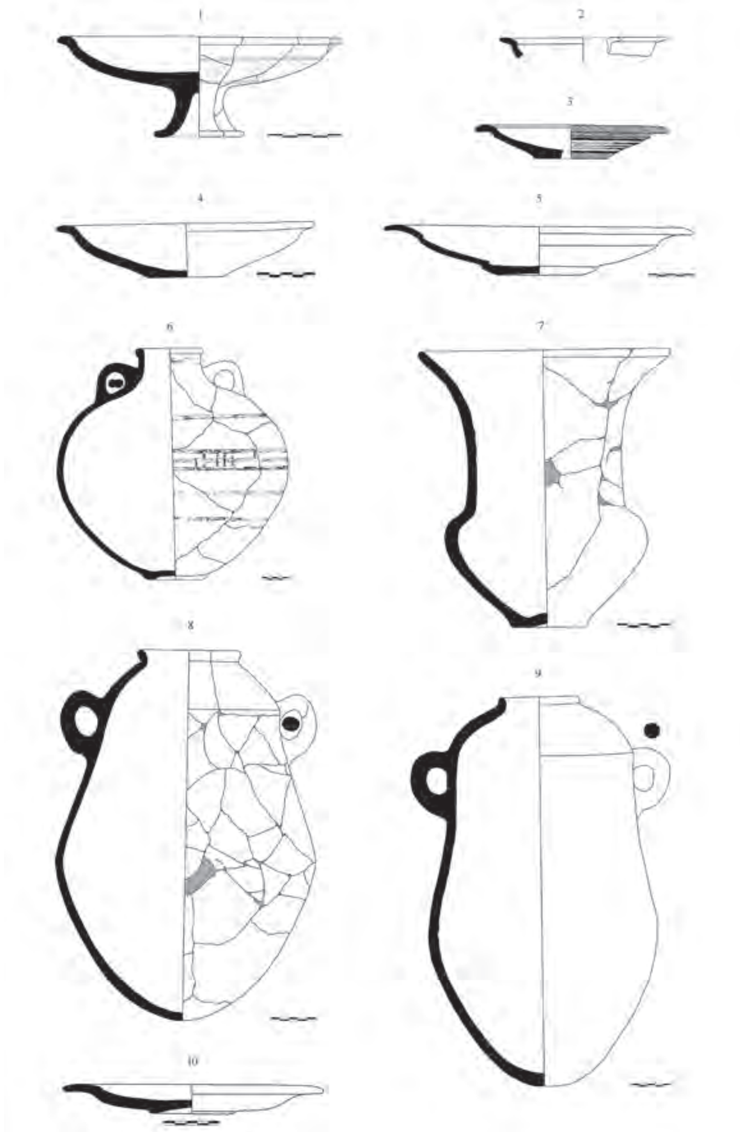

Fig. 2. 1: Cup, Setefilla, grave B7, sample 8 (after Aubet 1978, p. 23; digital drawing: B. Walkowski); 2: Plate (not to scale), Setefilla, grave A2, sample 18 (after Aubet 1975, p. 24; digital drawing: B. Walkowski); 3: Plate (not to scale), Setefilla, grave A62, sample 84 (after Aubet 1975, p. 75; digital drawing: B. Walkowski); 4: Bowl, La Joya necropolis (Huelva), grave 12, sample 140 (after Garrido Roiz – Orta García 1978, p. 32; digital drawing: B. Walkowski); 5: Plate, La Joya necropolis (Huelva), grave 12, sample 141 (after Garrido Roiz – Orta García 1978, fig. 28,3; digital drawing: B. Walkowski); 6: Cruz del Negro urn, La Joya necropolis (Huelva), grave 12, sample 141 (after Garrido Roiz – Orta García 1978, fig. 28,1; digital drawing: B. Walkowski); 7: *À chardon* vessel, La Joya necropolis (Huelva), grave 19, sample 146 (after Garrido Roiz – Orta García 1978, p. 164; digital drawing: B. Walkowski); 8: Amphora, La Joya necropolis (Huelva), grave 19, sample 147 (after Garrido Roiz – Orta García 1978, p. 161; digital drawing: B. Walkowski); 9: Amphora, La Joya necropolis (Huelva), grave 19, sample 148 (after Garrido Roiz – Orta García 1978, p. 162; digital drawing: B. Walkowski); 10: Bowl, La Joya necropolis (Huelva), grave 12, sample 157 (after Garrido Roiz – Orta García 1978, p. 30; digital drawing: B. Walkowski).

Each sample was analyzed six times at different locations: three times with "Major Mud Rock" analytical mode (voltage of 15kV, intensity of 25μA) and another three times with "Trace Mud Rock" analytical mode (voltage of 40kV, intensity of 15μA). These settings made it possible to excite the following elements: Mg, Al, Si, P, S, K, Ca, Ti, V, Cr, Mn, Fe, Co, Cu, Zn, Ba ("Major Mud Rock") and Ca, Ti, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Rb, Sr, Y, Zr, Nb, Mo, Sn, Sb, Ba, Pb, Th, U ("Trace Mud Rock"). Only the external surface was subject to analysis and the time of each analysis was 15 seconds. The values of each element were averaged and are presented in Tab. 2 and Tab. 3.

Previous studies showed that a potassium-titanium test is one of the suitable methods to group the chemical results in a comprehensive scheme.[14] Good clustering was also achieved when the following signif-

14 Krueger – Brandherm 2019, p. 79.

sample	Mg	Al	Si	P	S	K	Ca	Ti
8	0,509	5,700	19,845	0,078	3,910	0,523	7,320	0,197
18	2,923	11,196	20,557	0,234	0,162	1,337	13,099	0,399
70	0,866	7,310	15,850	0,179	0,135	1,096	13,226	0,404
84	2,319	5,132	13,042	0,000	0,084	0,604	6,931	0,246
86	0,275	7,205	14,191	0,188	0,149	1,288	11,774	0,363
127	1,064	12,605	20,439	0,297	0,161	1,468	9,173	0,303
128	2,340	9,094	23,131	0,333	0,173	1,138	8,030	0,429
130	3,645	7,866	20,701	0,538	0,063	0,930	11,551	0,394
139	0,654	7,063	23,342	0,064	0,606	1,505	0,858	0,439
140	0,650	6,294	20,567	0,031	1,130	1,128	3,620	0,350
141	0,941	10,440	27,245	0,065	0,417	1,417	0,736	0,503
143	0,767	8,096	22,368	0,042	0,354	1,592	0,869	0,497
146	0,787	11,579	22,818	0,070	0,279	1,275	0,820	0,476
147	0,636	6,668	21,185	0,065	1,996	0,794	2,702	0,513
148	3,340	7,045	22,765	0,148	0,300	0,979	6,192	0,654
149	0,672	11,148	27,255	0,059	0,276	1,311	0,674	0,393
157	0,976	8,027	21,614	0,105	0,961	1,378	8,076	0,417
173	1,212	6,976	21,721	0,170	0,038	0,993	2,161	0,527
185	0,354	6,293	15,457	0,133	0,147	1,309	11,244	0,381
186	0,637	7,347	16,629	0,183	0,147	1,141	7,929	0,566
188	0,807	10,568	24,186	0,126	0,154	1,301	3,712	0,536
191	1,820	10,114	23,168	0,180	0,175	1,647	9,328	0,434

sample	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ba
8	0,000	0,005	0,018	3,314	0,001	0,000	0,021	0,022	0,058
18	0,002	0,008	0,027	3,594	0,001	0,004	0,004	0,007	0,182
70	0,003	0,007	0,045	3,899	0,002	0,003	0,006	0,005	0,170
84	0,000	0,004	0,017	3,187	0,001	0,000	0,005	0,010	0,004
86	0,005	0,006	0,040	4,805	0,002	0,002	0,005	0,011	0,153
127	0,001	0,005	0,066	3,730	0,002	0,003	0,004	0,008	0,207
128	0,002	0,011	0,027	4,507	0,002	0,005	0,005	0,009	0,217
130	0,001	0,008	0,028	3,845	0,002	0,002	0,005	0,008	0,173
139	0,005	0,009	0,044	4,219	0,002	0,005	0,010	0,007	0,043
140	0,009	0,010	0,020	3,745	0,002	0,006	0,014	0,000	0,244
141	0,014	0,011	0,041	4,300	0,002	0,007	0,007	0,009	0,056
143	0,006	0,010	0,042	4,640	0,002	0,006	0,007	0,008	0,153
146	0,017	0,014	0,020	6,398	0,003	0,004	0,007	0,007	0,063
147	0,002	0,010	0,023	4,431	0,002	0,004	0,005	0,008	0,238
148	0,007	0,010	0,025	4,974	0,002	0,003	0,006	0,008	0,220
149	0,010	0,011	0,034	4,987	0,002	0,004	0,007	0,007	0,052
157	0,001	0,008	0,023	3,955	0,002	0,003	0,005	0,007	0,533
173	0,000	0,003	0,013	3,993	0,002	0,000	0,006	0,009	0,092
185	0,002	0,008	0,029	4,933	0,002	0,001	0,005	0,009	0,189
186	0,002	0,005	0,047	5,432	0,002	0,001	0,007	0,011	0,225
188	0,002	0,008	0,047	3,916	0,002	0,005	0,006	0,008	0,182
191	0,002	0,009	0,036	3,855	0,002	0,004	0,005	0,009	0,164

Tab. 2. Chemical results – Major Mud Rock analytical mode (by M. Krueger).

sample	Ca	Ti	Cr	Mn	Fe	Co	Ni	Cu	Zn	As	Rb
8	14,174	0,444	0,006	0,039	3,633	0,002	0,011	0,046	0,086	0,021	0,007
18	13,964	0,444	0,003	0,043	3,433	0,002	0,005	0,005	0,009	0,001	0,009
70	16,027	0,504	0,001	0,046	3,780	0,002	0,005	0,009	0,007	0,001	0,007
84	12,265	0,466	0,003	0,040	3,402	0,001	0,004	0,001	0,008	0,001	0,006
86	14,326	0,523	0,003	0,058	4,633	0,002	0,005	0,003	0,014	0,001	0,007
127	11,216	0,422	0,000	0,078	3,616	0,002	0,006	0,001	0,008	0,001	0,007
128	8,563	0,557	0,008	0,034	4,301	0,002	0,004	0,001	0,008	0,001	0,006
130	13,662	0,460	0,002	0,051	3,848	0,002	0,006	0,002	0,006	0,001	0,004
139	1,252	0,507	0,002	0,055	4,015	0,002	0,005	0,007	0,007	0,001	0,008
140	3,406	0,478	0,001	0,023	3,423	0,001	0,004	0,023	0,000	0,002	0,009
141	1,293	0,581	0,006	0,034	4,557	0,002	0,003	0,002	0,008	0,002	0,010
143	1,409	0,591	0,004	0,030	4,407	0,002	0,005	0,001	0,008	0,006	0,010
146	1,500	0,646	0,019	0,031	6,748	0,003	0,002	0,001	0,005	0,002	0,009
147	3,874	0,637	0,006	0,033	4,249	0,002	0,008	0,004	0,008	0,002	0,003
148	9,419	0,802	0,003	0,047	4,863	0,003	0,004	0,005	0,011	0,002	0,005
149	1,410	0,629	0,001	0,058	4,318	0,002	0,004	0,003	0,008	0,001	0,010
157	10,291	0,547	0,002	0,034	3,814	0,002	0,002	0,001	0,006	0,001	0,009
173	6,737	1,303	0,000	0,057	4,042	0,004	0,003	0,003	0,010	0,001	0,005
185	13,356	0,548	0,003	0,055	4,694	0,002	0,003	0,002	0,008	0,001	0,008
186	12,831	0,790	0,004	0,095	5,465	0,003	0,006	0,002	0,020	0,001	0,004
188	6,244	0,642	0,000	0,069	4,144	0,002	0,007	0,002	0,009	0,001	0,008
191	13,305	0,437	0,003	0,047	4,017	0,002	0,005	0,003	0,009	0,001	0,012

sample	Sr	Y	Zr	Nb	Mo	Sn	Sb	Ba	Pb	Th	U
8	0,034	0,002	0,012	0,001	0,001	0,000	0,004	0,115	0,004	0,001	0,000
18	0,038	0,003	0,013	0,001	0,001	0,000	0,002	0,144	0,001	0,001	0,000
70	0,044	0,002	0,014	0,001	0,000	0,000	0,001	0,009	0,001	0,001	0,000
84	0,032	0,003	0,014	0,001	0,001	0,000	0,000	0,005	0,001	0,001	0,001
86	0,034	0,003	0,016	0,001	0,000	0,000	0,001	0,014	0,002	0,001	0,001
127	0,026	0,003	0,019	0,001	0,000	0,000	0,002	0,145	0,002	0,001	0,001
128	0,029	0,002	0,018	0,001	0,000	0,000	0,001	0,060	0,001	0,001	0,001
130	0,034	0,003	0,019	0,001	0,000	0,000	0,001	0,146	0,002	0,001	0,000
139	0,008	0,003	0,021	0,001	0,003	0,000	0,001	0,033	0,002	0,001	0,001
140	0,007	0,003	0,026	0,001	0,001	0,000	0,001	0,088	0,002	0,001	0,000
141	0,006	0,003	0,024	0,001	0,001	0,000	0,002	0,169	0,002	0,001	0,000
143	0,007	0,003	0,023	0,001	0,001	0,000	0,001	0,154	0,003	0,001	0,000
146	0,008	0,003	0,017	0,001	0,001	0,000	0,001	0,029	0,002	0,001	0,000
147	0,016	0,003	0,019	0,001	0,001	0,000	0,002	0,178	0,002	0,000	0,000
148	0,026	0,003	0,020	0,001	0,000	0,000	0,002	0,110	0,002	0,001	0,000
149	0,007	0,003	0,020	0,001	0,001	0,000	0,001	0,007	0,001	0,001	0,000
157	0,019	0,003	0,020	0,001	0,000	0,000	0,001	0,226	0,001	0,001	0,000
173	0,024	0,003	0,016	0,001	0,000	0,000	0,002	0,122	0,002	0,001	0,000
185	0,042	0,003	0,013	0,001	0,000	0,000	0,001	0,026	0,001	0,001	0,000
186	0,036	0,003	0,017	0,001	0,000	0,000	0,001	0,161	0,001	0,001	0,000
188	0,019	0,003	0,022	0,001	0,001	0,000	0,001	0,207	0,002	0,001	0,000
191	0,031	0,002	0,014	0,001	0,000	0,000	0,001	0,230	0,001	0,001	0,001

Tab. 3. Chemical results – Trace Mud Rock analytical mode (by M. Krueger).

icant elements were used: Al, Si, K, Ca, Ti, V, Cr, Fe. However, as it was expected that the elemental composition of all wheel-thrown ceramic materials would be similar, an additional principal component analysis (PCA) test was employed based on Bonn statistical grouping[15] and adjusted to the analytical characteristics of the Trace Mud Rock mode for the pXRF Bruker Tracer III SD. The final set of chemical elements considered included Ti, Cr, Mn, Fe, Ni, Cu, Rb, Sr, Y, Zr, Nb.

3. Results

The samples analyzed can be classified in four different petrographic groups, from Group A to Group D, according to their composition and technological features. This classification shows a good correlation with the original context of the samples. The three vessels from El Carambolo correspond to Group A (2 samples) and Group B (1 sample). The selected pottery from La Joya is divided between Group B (4 samples) and Group C (5 samples). Finally, the assemblage from the Setefilla necropolis includes one sample of Group B and a higher representation of Group D (9 samples).

Group A can be described as a calcareous paste with presence of bioclastic packstone, limestone, quartz arenite, muscovite and plagioclase, tempered with meso rounded quartz grains (Fig. 3.1). It can be easily recognized by the predominance and distribution of microfossils (globigerines and orbulines) and elongated shell fragments in the clay matrix, which presents a very good alignment parallel to the walls of the vessel. The matrix is very slightly optically active, single- to close-spaced.

In spite of the archaeological origin of the analyzed samples, which come from the El Carambolo site at the ancient estuary of the Guadalquivir valley, this first petro-group represents a common fabric of the area of Carmona and Los Alcores. In fact, the bioclastic packstone clay is the traditional ceramic paste of this area. Previous studies of vessels from the Orientalizing period in Carmona, compared to the local clay quarries, have recognized the same defining characteristics of these fabrics.[16] Globigerines, rotalides and orbulines foraminifera and elongated shell fragments are frequent in the Miocene marls that have been historically used for pottery production in Carmona until recent times, including the protohistory period, as can be identified in the representative assemblage of pithoi, red slip plates and grey ware cups from Casa del Marqués de Saltillo.[17] Association with a single clay source in the vicinity of the Carmona settlement is complicated by the diversity of parameters in local raw clay materials and the technological processes of addition and removal of components during paste preparation,[18] but the relationship between the archaeological materials and the general geological setting of the area is consistent. Other areas of the Guadalquivir valley show a similar presence of abundant foraminifera as a characterizing feature of the litho-stratigraphic description of the geological setting,[19] but the consistency of this ceramic paste in Carmona and its connection with the lower Guadalquivir valley supports the identification of the samples from Group A. In fact, the same petrographic characterization can be tracked from the beginning of the Iron Age until the last the Turdetanian amphorae (type Pellicer D) fabricated in Carmona around the end of the 1st century BCE.[20] The pottery tradition seems to have a long history in this region, taking advantage of the same raw material supply areas from the very beginning of the Iron Age until the substitution of the local tradition by the Roman pottery industry.

15 Goren – Mommsen – Klinger 2011, p. 689.

16 Belén Deamos – Odriozola Lloret – Román Rodríguez 2018.

17 Gómez Morón – Polvorinos Del Río 1997; Navarro Gascón 1997.

18 Polvorinos Del Río – Gómez Morón 1996.

19 Barrios Neira *et al.* 2009.

20 Moreno Megías 2017; Moreno Megías in press; Ortiz Navarrete – Conlin in press.

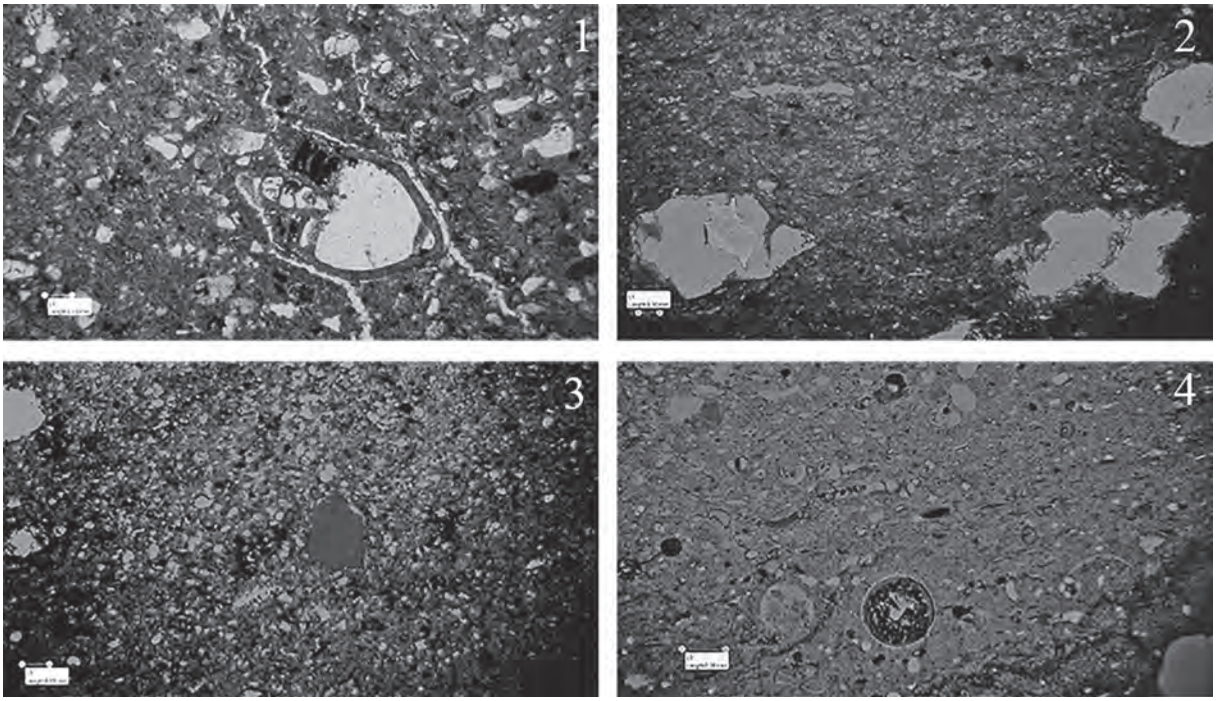

Fig. 3. Thin-section photomicrographs in cross-polarized light. 1: Sample 127, wheel-thrown plate from El Carambolo. Group A. Image width: 1.24 mm. 2: Sample 146, wheel-thrown *à chardon* vessel from La Joya necropolis (Huelva), Tomb 19. Group B. Image width: 2.71 mm. 3: Sample 139, wheel-thrown grey ware bowl from La Joya necropolis (Huelva), Tomb 12. Group C. Image width: 1.24 mm. 4: Sample 84, wheel-thrown plate from Setefilla necropolis, Tomb A62. Group D. Image width: 2.71 mm (photographs V. Moreno Megías).

Group B is present in all the archaeological contexts that have been taken into consideration. It is characterized by the fine-grained calcareous paste tempered with unevenly distributed fine quartz grains (Fig. 3.2). Less frequent components are microfossils, quartz arenite fragments, muscovite and, rarely, biotite and feldspars. Regarding the microstructure, the paste presents low porosity, composed of a few macro-mega voughs and occasionally thin channels through the paste. When pores or inclusions are elongated, they are very well oriented parallel to the walls. The matrix is not optically active. As for the textural features, only occasional macro-mega rounded brown clay pellets with micro quartz inclusions can be identified.

The composition of this petro-group does not facilitate the identification of the provenance of the samples, as the main components are non-diagnostic quartz grains, but its higher concentration in the necropolis of La Joya could indicate a strong connection to the city of Huelva, with the workshops responsible for its production. Mineralogical analyses have been previously applied to ceramic materials of Phoenician and indigenous tradition in the city of Huelva[21] and in other parts of the province such as Tejada la Vieja and San Bartolomé de Almonte, related to the exploitation of metallurgical resources.[22] The study of the latter settlement is especially relevant, as some materials from Cabezo de San Pedro in Huelva were used for comparison with the local assemblage, including red slip plates and amphorae. The published results obtained by

21 Millán Chagoyen *et al.* 1990.

22 Galván Martínez 1986; Arribas Fernández *et al.* 1989.

X-ray diffraction analysis of the calcareous pastes of the Phoenician red slip plates could be compatible with the petrographic characterization of Group B.[23] In this case, the ceramic recipe was different from the handmade pottery of Cabezo de San Pedro and was therefore considered a non-local production. However, the mineralogical definition is compatible with the geological setting of the area, as the microfossils and calcareous component is typical of the Neogene marine deposits of Huelva province.[24] A similar composition was described through X-ray diffraction and petrographic microscopy for a series of 6th century BCE Phoenician vessels from urban excavations in Huelva (Group II and, to a lesser extent, Group III)[25] and for a different set of archaeological pottery from Huelva considered as local production (Group II).[26] Local production of Greek pottery types (late 7th-half 6th century BCE) has been recently confirmed in Huelva through XRD, NAA and SEM analyses.[27] This work supports the use of the local calcareous marls[28] for the pottery fabrication, which is compatible with the petrographic composition of the analysed samples from La Joya.

At La Joya necropolis, all the samples in Group B belong to the same Tomb 19, which suggests remarkable consistency in the provenance of the funerary goods of this tomb, probably from a nearby local production center. In general, Group B includes mainly pottery types with a storage function, as *à chardon* vessels and amphorae corresponding to the Phoenician type T-10.1.2.1.[29] Only one sample, a bowl from El Carambolo, seems to be a discordant manufacture of this petro-group from a functional perspective. This eventuality could be related to the special nature of the presence of the bowl at El Carambolo, while amphorae and *à chardon* vessels could have been fabricated together from the same ceramic recipe, following precise requirements of strength and resistance in order to store food products.

Group C shares certain similarities with Group B and is also strongly related to the site of Huelva, considering that in the analyzed collection it is only present in Tombs 8, 12 and 16 of La Joya necropolis. It is defined by a characteristic yellow calcareous paste, more optically active compared to the previous petro-group (Fig. 3.3). The fine fraction is predominant and well sorted, mainly composed of quartz grains. Again, microfossils and muscovite inclusions are present with less frequency. The porosity is low, including a few macro-meso voughs and smaller vesicles. The orientation of pores and inclusions is clearly parallel to the walls, even when they are not elongated. The similarities with the previous group are numerous and a technological variation in the production process could be a case for the separation of the two sets, including lower firing temperature for Group C. As exposed for Group B, the connection with the geological setting of the site of Huelva is strong although the identification of the exact provenance is difficult. In any case, the samples from Huelva are petrographically consistent and compatible with previous research works and with the geological composition of the surrounding area and support the probable local provenance of the pottery selected as funerary objects. Typologically, Group C is composed by red-burnished plates, a grey ware bowl and a *Cruz del Negro* urn. This ceramic recipe was noticeably reserved to particular types of tableware, with only one presence of an urn. However, this type of urns can be more likely classified as fine ware than storage pottery, so a relation with plates and bowls is more probable than with the amphorae and *à chardon* vessels petro-group. Among the samples, the red-burnished plates are made of the most depurated pastes, which could form a subgroup on their own. Moreover, these plates present an external layer of ferrous slip that can be easily identified in the petrographic analysis.

23 Galván Martínez 1986, p. 297.

24 González Delgado *et al.* 2004.

25 Millán Chagoyen *et al.* 1990, pp. 407, 415.

26 Arribas Fernández *et al.* 1989, p. 248.

27 González de Canales Cerisola – Llompart Gómez 2017.

28 Galán Huertos – González Díez 1993.

29 Ramón Torres 1995.

Unlike the assemblage from La Joya, the different origins of the pottery found at El Carambolo (Groups A and B) indicate the preference for products which were most likely not locally made.[30] This situation can be related to the religious character of the site, where a Phoenician temple has been excavated.[31] The vessels which were brought to this place could have come from different parts of the southwest region of the Iberian Peninsula (around the lower Guadalquivir valley and the coast of Huelva) responding to a character of religious offerings or tributes. In any case, they could also be the reflection of the arrival of people from different areas to this particular site, bringing with them commodities and/or tableware.

Group D appears as a well-defined set of Phoenician pottery from the Setefilla necropolis. It is characterized by a fine-grained calcareous matrix, not optically active, with predominance of meso microfossils, mainly benthonic and planktonic foraminifera and ostracods (Fig. 3.4). While the bioclasts are the main coarse inclusions, some samples present less frequent quartz grains, quartz arenite fragments and clay nodules. These nodules are defined as brown-red clay pellets or swirls characterized by their angular shape and meso size, distinct boundaries and not optically active matrix, absence of inclusions or the only presence of few micro muscovite and quartz grains. Moreover, among the inclusions of the matrix, plagioclases, biotite and muscovite range from 10% to entirely absent. The porosity is very low as it is only composed of micro-meso vesicles inside the microfossils or very thin channels through the paste. The orientation of the inclusions is parallel to the walls, while the spacing of the inclusion distribution is open. The fine fraction is predominant, very well sorted and mainly represented by micro quartz grains. The typological variability of this petro-group is represented by plates, cups and one *à chardon* vessel. However, it is important to state that, while the tableware is extremely consistent in the definition of its matrix and inclusions, the *à chardon* vessel could be classified as a subgroup of the main ceramic recipe. More concretely, the matrix is generally less fine and among the inclusions there is a higher presence of quartz and quartz arenite fragments and clay nodules, although the microfossils continue to be dominant.

Compared to the traditional locally-made pottery of Setefilla, the Phoenician wheel-thrown vessels included in Group D are very different and could have represented imports from a different geographical area, possibly also in the SW region of the Iberian Peninsula, although from a merely petrographic point of view the provenance is difficult to determine. The evidences for the establishment of Phoenician pottery workshops are among the first colonial artisan activities in the SW Iberian Peninsula.[32] In addition to the first foreign manufacture of pottery in Huelva at the beginning of the Phoenician presence,[33] the compositional diversity of the western Phoenician repertoire is related to multiple production centres. However, the evidences of pottery kilns between the 8th and 6th centuries BCE are not equally abundant in the colonial settlements of Andalusia, fortunately increasing during the Punic period.[34] The multiple production sites of San Fernando (Cádiz) and the workshop of Cerro del Villar (Málaga) are the main examples of such structures. Considering the typological definition of the vessels that compose our Group D and the existence of archaeological remains of pottery kilns in the region, archaeometrical analyses of Phoenician pottery from the Cádiz area and the coast of Málaga can be compared to the characterization of Group D as possible provenance areas for wheel-thrown pottery imported in Setefilla, while at the same time they respect the

30 Compare with the numerous studies of the ceramic materials from settlements of the same area in the lower Guadalquivir valley such as Cerro Macareno: González Vílchez 1983; González Vílchez *et al.* 1983; González Vílchez – González García – García Ramos 1983; González Vílchez – García Ramos – González García 1985a; González Vílchez – García Ramos – González García 1985b; González Vílchez – González García – García Ramos 1985.

31 Fernández Flores – Rodríguez Azogue 2005.

32 Delgado Hervás 2011.

33 González de Canales Cerisola – Serrano Pichardo – Llompart Gómez 2004.

34 Sáez Romero 2011.

traditional characteristics of imported ware from Phoenicia.[35]

Firstly, the characterization of this petro-group does not seem to represent the typical mineralogical composition of the Phoenician pottery of the first settlements situated along the coastal area of Málaga, where one of these Phoenician pottery workshops has been excavated, Cerro del Villar, an active production centre since the 8th century BCE.[36] The productions of this area, both in the workshop and in other settlements, present a higher diversity of inclusions and the characteristic presence of metamorphic rock fragments and minerals.[37]

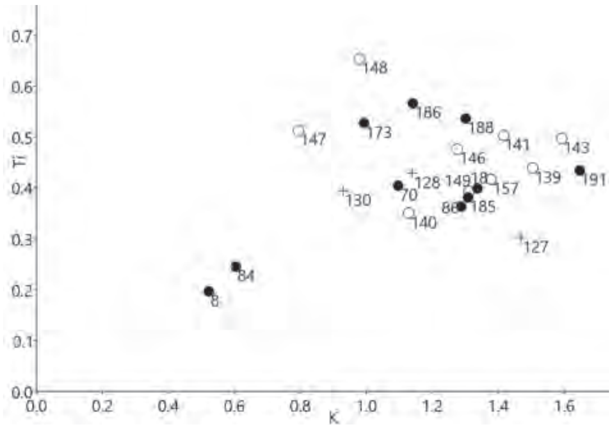

Fig. 4. K-Ti test of the wheel-made samples from El Carambolo, Huelva – La Joya and Setefilla (black dots – Setefilla, white dots – Huelva La Joya, plus – El Carambolo) (by M. Krueger).

On the other hand, the ceramic material from the Camposoto workshop (San Fernando, Cádiz), dating between the late 6th century BCE and the mid-5th century BCE, is closer to the petrographic description of Group D.[38] The components, microstructures and textural features in Cádiz are more similar to this petro-group than other Phoenician productions from the southern Iberian Peninsula, although the proportion of bioclasts is clearly higher in the assemblage from Setefilla. Other analyses have been conducted on manufactured items from the production areas of Puerto Real and San Fernando[39] and Puerto de Santa María.[40] In this case, the general mineralogical characteristics are again respected by the Phoenician vessels of Setefilla's Group D. Particularly interesting is the characterization proposed for Group 4 of Johnston's classification of samples from San Fernando and Castillo de Doña Blanca,[41] defined by the same high proportions of monocrystalline quartz grains, calcite and microfossils and minor quantities of feldspars. Consequently, the wheel-thrown pots studied are closer to the Phoenician pottery tradition of the Cádiz area than to the local hand-made production[42] or other possible colonial areas. In any case, the homogeneity of the petrographic characterization of this petro-group indicates a very consistent supply of pottery coming from a reduced geographical area, possibly from one single workshop, with a common destination: the funerary contexts of Setefilla.

The potassium-titanium test shows (Fig. 4) that the wheel-thrown pottery from Setefilla is much more diverse than a group of samples studied in a previous work.[43] The possible reason of this phenomenon is that the range of wheel-thrown samples used in this study is broader than in the previous one.

35 As part of the same on-going research project, a direct comparison of Group D with Phoenician pottery from Jiyeh (Lebanon) has been proposed. Preliminary analyses indicate considerable similarities in the paste treatment and raw material selection, resulting in an analogous fine-grained calcareous paste, not optically active, with a similar predominance of meso microfossils. These results match previous characterization of pottery from Phoenicia (Miguel Gascón – Buxeda Garrigós 2013) and facilitate the possibility of an assimilation of the wheel-thrown set of Setefilla with imported ware from Phoenicia. Further studies of the microfauna will contribute to this determination.

36 Aubet *et al.* 1999.

37 Pringle 1988; Amadori – Fabbri 1998; Cardell Fernández *et al.* 1999.

38 Cau Ontiveros 2007.

39 Domínguez Bella *et al.* 2004.

40 Edreira Sánchez – Feliú Ortega – Villena De la Cruz 2001; Feliú Ortega – Edreira Sánchez – Martín Calleja 2004; Johnston 2015.

41 Johnston 2015, p. 222.

42 Polvorinos del Río *et al.* 2005.

43 Krueger – Brandherm 2019, p. 80.

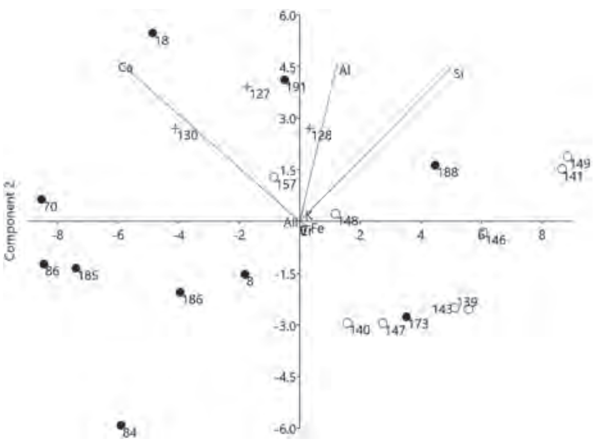

Fig. 5. Principal component analysis (PCA) of the wheel-thrown samples from El Carambolo, Huelva – La Joya and Setefilla using the following elements: Al, Si, K, Ca, Ti, V, Cr, Fe (black dots – Setefilla, white dots – Huelva La Joya, plus – El Carambolo) (by M. Krueger).

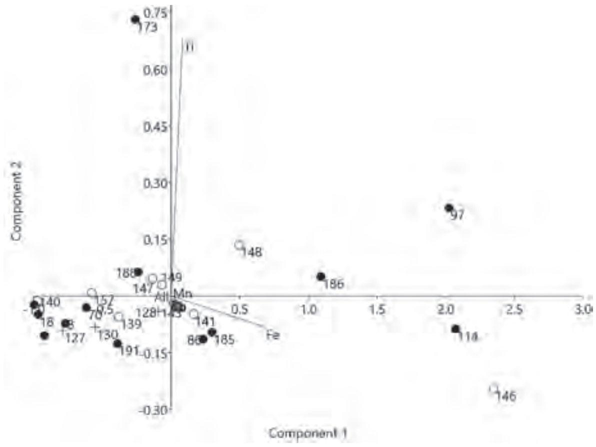

Fig. 6. Principal component analysis (PCA) of the wheel-thrown samples from El Carambolo, Huelva – La Joya and Setefilla using the following elements: Ti, Cr, Mn, Fe, Ni, Cu, Rb, Sr, Y, Zr, Nb (black dots – Setefilla, white dots – Huelva La Joya, plus – El Carambolo) (by M. Krueger).

PCA using Al, Si, K, Ca, Ti, V, Cr, Fe offers a visualization of three clusters: one from La Joya and other two from El Carambolo and Setefilla (Fig. 5). There are some samples from Setefilla (for example 173, 188, 191, representing an *à chardon* vessel and two unknown forms) which are dispersed in the graph. Good clustering of wheel-thrown samples from La Joya is visible in the PCA graph using trace elements: Ti, Cr, Mn, Fe, Ni, Cu, Rb, Sr, Y, Zr, Nb (Fig. 6). The elemental composition of ceramic materials from Setefilla is much more diversified than samples from La Joya and El Carambolo, even when they are all petrographically very similar among them. In the case of samples from La Joya, levels of strontium are considerably lower than from other sites[44] and levels of vanadium and chromium remain high (see Tabs. 2 and 3).

4. Conclusions

The spectrometric and petrographic analysis of samples has provided data to define clay matrix, temper and elemental composition of pottery in the Phoenician tradition from western Andalusia. These analyses have added new data to the characterization of the local production of the area during the Late Bronze Age and the Orientalizing period, focusing on the definition of the Phoenician pottery tradition in western Andalusia.

The results indicate a possible link between some archaeological sites and certain compositional characteristics, as in the case of the sherds from Huelva La Joya, where the tombs seem to have acquired the grave goods as a single pack with a definite production origin. In general, the analyzed pottery manufactures from Huelva classified as petro-groups B and C seem very close to the characteristic Phoenician production modes and could be identified as local manufactures, considering the cited previous research works and the compatibility with the regional geological setting. In general terms, the pottery assemblages of La Joya are very consistent and show a clear distinction between vessels with a main storage function (Group B, limited to one single grave) and finer forms of tableware (Group C).

44 Compare with González de Canales Cerisola – Llompart Gómez 2017.

In the case of the funerary contexts of Setefilla, the wheel-thrown pottery that defines Group D is very consistent from a petrographic point of view and is not directly linked to any other well-characterized colonial production, although its general characteristics match the typical production modes and compositional features of the area of Cádiz. The petrographic homogeneity of Group D does not correspond, nevertheless, to the dispersion of the chemical composition of the Setefilla assemblage, a circumstance that will be considered in depth in future steps of the on-going research project. Only one wheel-thrown sample from the necropolis is different from this petro-group, as it belongs to Group B, one of the probable local recipes from Huelva. Unfortunately, the lack of typological identification for this piece prevents us to propose a relation with a precise pottery element.

Finally, the reduced group of tableware samples from El Carambolo, with a representation of Groups A and B, shows the variability of geographical provenances from the region among the ceramic assemblage that arrived to the sanctuary area. In this case, the connections between El Carambolo, the region of Los Alcores (an active focal point of the Orientalizing period) and the probable production centers in Huelva are emphasized by the presence of bowls and plates in the religious space.

The difference between the local, hand-made production and the high quality wheel-thrown pottery, identified as Phoenician ware due to their morpho-typology, indicates that contemporaneous productions did not share raw material sources or technological processes in the productive chain in this moment. As an example of the traditional local production, biconical urns from the same contexts in Setefilla show different compositional and technological characteristics, much more related to the geological environment of the site. Wheel-thrown pottery manufacture was not, consequently, a local activity for the supply of the funerary goods of the Setefilla settlement.

Lastly, in order to confirm the proposed provenance of the analyzed samples – based on the petrographic and chemical composition and a comparison with relatable assemblages of SW Iberian Peninsula – it is needed to correlate the present data with the results of previous research works on pottery from Phoenician colonies,[45] a subject of the ongoing project.

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45 For example Behrendt – Mielke 2011; Behrendt – Mielke – Tagle 2012; Behrendt – Mielke 2014.

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